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# ANNEXURES

TO THE

# REPORT

OF THE

## JOINT POWER ALCOHOL AND MOLASSES INQUIRY COMMITTEE

BIHAR AND THE UNITED PROVINCES

1938



ALLAHABAD:  
SUPERINTENDENT, PRINTING AND STATIONERY, UNITED PROVINCES, INDIA  
1938



**Annexures to the Report of the Joint Power Alcohol and Molasses Inquiry Committee (Bihar and the United Provinces), 1938**

*Note of dissent by Dr. S. S. BHATNAGAR, on paragraph 37 of the Report*

Dr. Bhatnagar is of the opinion that the changed figures which take into consideration the cost of power alcohol up to the stage of bulk delivery at the petrol depot are not what the public are concerned with. It is the cost of the mixed fuel which matters to them. In any case to the figures for the cost of alcohol up to the stage of bulk delivery will have to be added the cost of mixing which should include the losses in mixing and the charges on the capital outlay on mixing appliances. Thus while whole-heartedly supporting the mixed fuel as a national measure, which will lead to the development of other industries, he wishes to convey without hesitation his considered opinion that the measure will have to be adopted without any hope of great profits either to the consumer or the peasant.

*Note by Dr. N. R. DHAR*

From time immemorial alcohol has been produced by fermentation of materials containing sugars. As molasses is rich in sugars, it is certainly a suitable starting material for the production of alcohol for power and industrial purposes. But so far no firm or private individual in India has produced in bulk dehydrated alcohol suitable for mixing petrol for running motor vehicles. Moreover the cost of dehydration, mixing with petrol and loss due to evaporation are not known accurately in this country, hence the sale price of petrol-alcohol mixture is difficult to ascertain definitely. The figures therefore in paragraph 36 and some other sections of the report are only approximate. However, from the national viewpoint, manufacture of power alcohol is of vital importance; but from the point of view of profit either to the consumer, manufacturer or the peasant, it is not very satisfactory. Naturally other channels for the utilization of molasses have to be worked out. I have discussed this problem in detail in my presidential address to The Science Academy, United Provinces, on 19th December, 1935.

*Note by Mr. M. P. GANDHI*

In this note, I propose to deal with one or two important issues concerning the *raison d'être* of the Power Alcohol Industry in the United Provinces and Bihar.

In view of the known attitude of the petroleum interests towards the development of the Power Alcohol Industry in India, and the great influence which the oil interests exert on the Governments of various countries all over the world, I feel apprehensive that even in spite of our clear pronouncement\* in favour of the commercial practicability of utilization of molasses for the manufacture of power alcohol in the United Provinces and Bihar, and our recommendation of this method of utilization of molasses as a sound proposition from the economic point of view, the Government of India may be chary on creating conditions for, and look askance upon the immediate establishment of this industry. The development of the Power Alcohol

\*The Government of India are awaiting the pronouncement of the Joint Committee appointed by the Governments of United Province, and Bihar before deciding about giving licences permitting the manufacture of power alcohol and about making it compulsory for petrol to be mixed with power alcohol. *Vide interpellations in the Central Legislative Assembly, nos. 973, 975, 976, 981, dated the 24th March, 1938, and no. 1163, dated the 4th April, 1938.*

For a detailed discussion of the views held by the Government of India in this connection, *vide "The Indian Sugar Industry Annual"*, 1936 and 1937, by Mr. M. P. Gandhi.

Industry which incidentally, satisfies all the conditions necessary for the establishment of a new industry, viz. cheap and regular supply of raw material, adequate supply of labour and the availability of a vast home market is a question of paramount importance to the United Provinces and Bihar in view of the imperative necessity of finding a suitable and profitable outlet for molasses, an important by-product of their largest industry, in the safety and progress of which they are vitally interested, particularly, due to its effect on the ryots, to whom the cane crop is a very important cash crop, the annual value of which runs into millions of rupees, and which has, therefore, a great bearing on their welfare and wellbeing.

Being far removed from the sea-ports of India, these two Provinces are denied the opportunity of developing certain industries which Provinces near the sea-board can develop, and it is, therefore, only meet that the United Provinces and Bihar Governments should evince an anxiety (and indeed, should on that account be helped by the Central Government) to utilize this opportunity that has offered itself, as a result of the marvellous development of the sugar industry in both these Provinces\*, of the establishment of the Power Alcohol Industry, and of thus creating at once a new channel of employment for indigenous capital and a new avenue for harnessing the energy of a few educated and middle class people in this as well as other subsidiary industries which are bound to spring up as a consequence of the development of this industry and of thus utilizing an important by-product of great potential value which far from being a source of profit, as it should be, causes some expenditure in its disposal, and what is more, threatens to be a menace to the public health in the surrounding districts on account of its disagreeable smell and pollution of water if it is allowed to run into an adjacent water course.

Power alcohol has been produced on a commercial scale from molasses in various countries of the world like Austria, France, Phillipines, Czechoslovakia, Germany, United States and England, and there seems to be no particular technical complication in the manufacture of absolute alcohol which the industrialist may have to tackle. I am convinced that under the present circumstances and conditions, the manufacture of power alcohol is one of the most profitable directions for the utilization of molasses, from the economic point of view. I have little doubt that the Indian Tariff Board (Sugar) which conducted a comprehensive inquiry in the year 1937 (whose report although submitted to the Government of India in December, 1937 is not yet published) in this subject, will also endorse this view wholeheartedly.

While the development of this industry has been commenced, and indeed, carried out in most other countries at considerable expense to the State, which has even given subsidies of large amounts for a number of years, India is in the fortunate position of being able to develop this industry without any loss whatsoever to the revenue either of the Provincial or the Central Government. Indeed, it may bring some revenue to the Provincial Governments.

I also feel that the only way of reducing the huge and increasing drain of the national wealth on account of the imports of petroleum, methylated spirit and of varnishes, lacquers, etc., lies in the development of the Power and Industrial Alcohol Industry within the country. The annual import of petrol into India is of the order of 102,000,000 gallons valued at over five

\*Specially in the case of the United Provinces, where there are no coal deposits another important consideration is that power alcohol is the only indigenous fuel that may become available there, at a competitive rate with other liquid fuels

crores, and of methylated spirit of the order of 379,000 gallons valued at over three lakhs, and such imports mean a drain of a very large amount of money. The replacement of every gallon of imported petrol and methylated spirit by indigenous power alcohol and industrial alcohol will mean an indirect increase in the national wealth which is greatly needed in view of the appalling poverty of millions in India\*.

I further feel that if the Government of India should choose to levy the same excise duty on power alcohol as is levied on import of petrol, viz. annas 10 per gallon, they should allocate a suitable portion of the proceeds of such duty to the United Provinces and Bihar for purposes of development, just as they do in the case of revenues from income-tax from which portions are allocated to the Provinces, in the case of the import duty on petrol from which allocations are being made to the various provinces for road development, and in the case of the excise duty on sugar from which allocations are made to the various provinces for development of cane.

The establishment of this industry would also be helpful in checking any unwarranted increase in the price of petrol which, it may be observed, is dependent not upon the cost of production, but upon many other extraneous factors difficult to gauge. The availability of power alcohol in the country, would, therefore, give us a certain amount of independence from the monopolistic position of producers of petrol, and would at the same time give us a substitute motor fuel, which is vitally necessary for a nation under modern conditions†.

I also feel, particularly, after the separation of Burma from India in April, 1937, that it is eminently desirable for India to develop an alternative source of motor fuel inside the country, to ensure supplies of petroleum in the event of there being difficulties due to sea blockage or other reasons in bringing petrol from Burma or from other countries from where imports have been steadily increasing‡.

The development of the Power Alcohol Industry is particularly to be welcomed, because, a perennial supply of cheap and excellent raw material, viz., molasses produced in sugar factories is assured. The development of this industry would also render it less necessary to exploit, at once our indigenous mineral oil resources in the Punjab and Assam. These oil resources are, after all, wasting assets, and indeed may well be preserved for the future, if possible.

I do feel that United Provinces and Bihar can supply power alcohol for use as fuel to other areas in the interior of the country like the Punjab, North-West Frontier Province, Rajputana, Central India, Northern Central Provinces, portions in Bengal adjacent to Bihar, etc. at competitive rates

\*If the recommendations made in the Report are accepted at least 2·5 million gallons of Power Alcohol would be made in the two Provinces and about Rs.12 lakhs will remain in the country. To produce this quantity of power alcohol, about 7,000 tons of coal, 600 cwt. of sulphuric acid and 900 cwt. of Ammonium sulphate—all of Indian manufacture would be required.

†Past experience has shown how the petroleum interests are prepared to make an abnormal reduction of rates of petrol, for temporary periods and in restricted areas to meet competition of any competitor on the field, with a view to make it impossible for him to carry on profitably for any length of time.

‡The import of petrol from Burma during the year 1937-38 was 33,395,010 gallons valued at Rs.3,42,68,480 and from "other countries" 38,660,607 gallons valued at Rs.1,88,03,419. The total import of petroleum during 1937-38 was 102,055,617 gallons valued at Rs.5,30,61,819. It is a matter of interest to note that the import of petroleum from "other countries" has increased considerably during the last 3 years. In 1935-36 it was 2,077,775 gallons, in 1936-37 9,747,486 gallons, in 1937-38, 38,660,607 gallons. The average value of imported petrol as declared before the Customs Department during the year 1937-38 works out to 8 annas 4 pice per gallon, while the average declared value of petrol imported from Burma alone works out to 8 annas 8 pice per gallon at the ports.

under present conditions, without any difficulty, if the requisite legislation for compulsory admixture of power alcohol with petrol is passed.

It is needless to say that if power alcohol is required for the whole of India for purposes of admixture with petrol as motor fuel, it will be possible to produce the entire quantity required for use in the country. The addition of a percentage of power alcohol to the petrol will improve the quality of the petrol (by increasing the Octane number) and I therefore trust that the petroleum companies will readily agree to do so.

I hope that other Provinces in India will also lend their unstinted support to this scheme for the development of this industry, and thus enable the establishment of a new industry which will be an important step leading to a further industrialization of the country, ever so necessary to reduce the pressure of population on the land.

I would like to warn the Governments of United Provinces and Bihar, however that there is a danger of the petroleum interests reducing their prices of petrol to an unduly low level for a short time with a view to hamper or check the development of this industry, to prevent the use of power alcohol as a substitute by making over a reduction (it will only be for a temporary period remembering the object for which it is needed). They may even gain the sympathy of the consumers, and indeed, the bogey of protection of consumers' interests might also in all probability, be put forward from various quarters with a view to defer action for establishment of this industry. In such an event, however, the Government should be fully ready and equipped to face this situation and take suitable and prompt action.

I hope, however, that the petroleum distributing organizations who have benefited considerably from their monopoly in this trade for several decades, will take a farsighted and businesslike view, and will not let such a situation arise. In fact, their market will be taken away only to a very small extent due to the admixture of power alcohol, and the effect on them will be negligible, particularly, as the consumption of petrol is consistently and steadily increasing. On the other hand, the ungrudging co-operation of the Petroleum Distributing Organizations, with this new Power Alcohol Industry, which the Governments are anxious to develop, in the matter of marketing the mixed fuel, will be appreciated by the Governments, whose help and goodwill may be of considerable value to the Distributing Companies in the smooth running of their business.

#### *Minority report by MR. P. S. MAKER*

The Government of Bihar, in consultation with the Government of United Provinces appointed a joint Power Alcohol Committee on 18th January, 1938, with the following terms of reference:

*First—(a) to devise ways and means of starting the manufacture of power alcohol out of molasses.*

*(b) to report on the best method of manufacture and of mixing power alcohol with petrol.*

*Second—to explore other possible uses for molasses and their practical applications.*

The manufacture of power alcohol had been widely discussed in India for the past several years, and with the recent development of sugar industry making available large surplus of molasses, this question has assumed an all India importance. The fact that the alcohol-petrol mixtures are being

successfully used as motor fuels, in most of the countries abroad, it was very appropriate for the two Governments to appoint the said Committee to draw up a practical scheme for the manufacture of power alcohol out of molasses and to report on the utilization of molasses for purposes other than power alcohol.

The majority report is based on a strictly literal interpretation of the terms of reference. Though it was clear that the power alcohol when developed in United Provinces and Bihar alone, would not solve the molasses problem still my colleagues preferred to restrict the scope and method of inquiry and treated the entire subject-matter in a more general way, with the result that the majority report does not present any definite scheme for the manufacture, mixing and distributing of power alcohol. My report on the other hand treats the molasses problem on all India basis and satisfies the requirements of the terms of reference. The report is presented in three parts—*Part I* deals with the manufacture, cost and distribution of power alcohol, and *Part II* takes up the production of Industrial alcohols and converting the same into Commercial Solvents and alcohol products that have a ready market in India, and lastly *Part III* summarizes the recovery of distillery by-products such as : Dry Ice, Yeast, Potash and Ammonium Sulphate Fertilizers, etc.

## PART I

## POWER ALCOHOL

1 Most of the vegetable crops containing starches, such as, cereals, potatoes, etc., and those containing ready formed sugars, such as sugarcane with its residual molasses, fruits of various kinds and other things like waste wood and straw from the basic raw materials for the manufacture of power alcohol. In Great Britain, power alcohol is manufactured mainly from cereals and imported molasses. In Germany potatoes are chiefly used, while in France Alcohol is chiefly made from beet molasses and in the United States of America, maize and Cuban molasses form the basic raw materials for alcohol manufacture. India with practically little petroleum resources of her own must industrialize her agriculture for the manufacture of power alcohol so that we may increasingly be less dependent on foreign petrol and kerosene oil.

Petrol consumption in India primarily by the motor transport, is steadily increasing and for the year 1937-38, it reached 110 million gallons. Imports of kerosene oil into British India for the year 1936-37 amounted to 182 million gallons of which 120 million gallons came from Burma and 62 million gallons from other countries. Fuel oil imports average to 140 million gallons a year. In different countries, depending upon the circumstances the percentage of power alcohol in alcohol-petrol mixture varies from 10 per cent. to 50 per cent. and in certain cases like France there are two or more alcohol-petrol compulsory mixtures that are marketed for different class of motor transport.

If the laws of economics and nationalism, permit most of the western countries to mix power alcohol with petrol the same laws must equally hold good for India, especially when India has little oil supplies of her own and has 350,000 tons of surplus cane molasses to dispose off and by further developing her agriculture she can produce any amount of Power alcohol at prices unheard of in the world's markets.

2. Petrol replacement—In the year 1936-37, India produced 18 million gallons of petrol, imported 73 million gallons from Burma and about 10 million gallons from Iran, etc. Estimated consumption for the year 1937-38 is 110 million gallons. Of this 19 million gallons are consumed by the Indian States and about 1 million gallons for aviation purposes. The balance of 90 million gallons of petrol has to be replaced partly or totally with power alcohol. Although the percentage of light cars running is considerably higher than the heavy type of vehicles, it is estimated that the light motor vehicles consume annually 50 million gallons of petrol and the heavy type like lorries and buses consume the balance of 40 million gallons. For the light motor vehicles and taxi cabs the following fuel mixture is recommended :

## Mixture A

Winter four months (N. W. India)			Summer eight months		
November, December, January, February					
Per cent.			Per cent.		
20 Power Alcohol	..	..	25 Power Alcohol		
5 Ethyl Ether	..	..	75 Petrol		
75 Petrol	..	..			
100			100		

This will provide annual outlet for 12½ million gallons of power alcohol. For the heavy type of motor vehicles like buses, lorries and vans, etc., the following mixture is recommended :

*Mixture B*

<i>Winter four months (N. W. India)</i>			<i>Summer eight months</i>		
November, December, January, February					
Per cent.			Per cent.		
40 Power Alcohol	..	..	50 Power Alcohol.		
10 Ethyl Ether	..	..	50 Petrol.		
50 Petrol	..	..			
<b>100</b>			<b>100</b>		

This will absorb another 20 million gallons of power alcohol thus leaving a balance of 57·5 million gallons of petrol to be imported every year. And it is suggested that the same be imported from Burma alone in exchange for Indian produce. Besides the above two Mixtures A and B absorbing nearly 32·5 million gallons of power alcohol a year, there should be a separate motor transport organization, on all India basis, for marketing straight power alcohol as motor fuel. This mixture C will consist of 80 per cent. power alcohol and 20 per cent. Ethyl Ether. This national fuel under State subsidy will sell at 2 annas per gallon less than Mixture B while Mixture A, which is really a luxury fuel for the rich man's car, will pay a sale tax of 2 annas per gallon. This national transport system, run exclusively on power alcohol will operate as separate economic units in each Province as Feeder to Railway Service, especially to handle inter-provincial goods traffic in Agricultural produce. Plying about 1,000 alcohol trucks and lorries throughout India yearly consumption of Mixture C will reach 5·5 million gallons, thus replacing a total of 38 million gallons of imported petrol with home made Power Alcohol and saving India nearly Rs.190 lakhs a year.

3. *Kerosene replacement*—Out of 182 million gallons of kerosene imported annually into India, it is estimated that 150 million gallons are used for illuminating or lighting purposes and the balance of 32 million gallons are used for fuel or as source of power generation, for water works, kerosene Engines and Farm Tractors.

4. Before the discovery of Petroleum and its refined products Alcohol was universally used for illuminating purposes. In the year 1860, America alone consumed over 13 million gallons of Alcohol of 95 per cent. straight for lighting purposes.

5. In the year 1900 and 1906 photometric tests were made to determine the comparative value of Alcohol and kerosene as illuminants. These tests included the French "Bovin" incandescent mantle alcohol table lamp and an ordinary flat-wick kerosene table lamp using a good quality of alcohol (95 per cent.) and kerosene.

TABLE I

Lamp	One gallon will last	Candle power	Candle power hours
Alcohol .. .. .. .. ..	58 52	25	1,471
Kerosene .. .. .. .. ..	87 0	9	783
Alcohol .. .. .. .. ..	57 05	30.35	1,722
Kerosene .. .. .. .. ..	28 40	30.8	883

6. The test data conclusively prove that if we had two lamps of equal candle power and equal capacity, or one burning alcohol and the other kerosene alcohol lamp would burn nearly twice as long as the kerosene lamp or in other words a gallon of alcohol possesses about twice the illuminating value of a gallon of kerosene. Power alcohol, therefore, can compete successfully with kerosene at twice the cost per gallon. Outside of cost considerations, there are a number of other features in favour of alcohol lamp which are summarized below :

(1) The alcohol lamp is much safer than the kerosene lamp as fire started from Alcohol is readily extinguished by water which mixes with Alcohol in all proportions.

(2) The heat given off by radiation is much less in the case of Alcohol lamp.

(3) The white light furnished by the Alcohol lamp is a kind of day light in its quality and being also extremely steady and uniform it is preferable to the light of the Kerosene lamp.

(4) As the Alcohol lamp burns no wick it is free from this troublesome feature. The Alcohol lamp does not smoke and is practically odourless. The fitting on of the mantle is easy and simple. The lighting of the Alcohol lamp is more easily done with Kerosene as the removal of the chimney is unnecessary.

7. The only argument that may be advanced against the use of Power Alcohol in place of Kerosene, is of the prohibitive cost of Alcohol lamp and it is stated that an ordinary table type Alcohol lamp will cost Rs.10 while a Kerosene lamp of same type and size would cost Rs.5 only. The explanation is that there being no demand for alcohol lamps, their prices must be higher than of kerosene lamps. We all know that with the increase in demand, an ordinary hurricane lantern that used to cost Rs.3 a piece, can be had now at less than Re.1 in any corner of India and as a matter of fact there are two or three Indian establishments who are now manufacturing these lanterns by employing automatic machinery. Similarly, by creating demand for the Alcohol lamps same will be manufactured in India at popular prices including the Mantles. As a matter of constructional details there is nothing complicated in an Alcohol lamp. Its chief difference lies in its design of the burner which is easily regulated. Thus the amount of light furnished, and hence of Alcohol used, can be reduced at will. It would be the duty of the State to subsidize Alcohol lamp manufacture and so regulate the Alcohol Industry that it may eventually replace 182 million gallons of Kerosene and save India nearly Rs.550 lakhs a year.

As stated above, the declared value of a gallon of Kerosene Oil is 4 annas and 10 $\frac{1}{2}$  pies and the excise duty is 2 annas and 9 $\frac{1}{2}$  pies per gallon. On to this may be added 1 anna and 6 pies as transport charges and 1 anna and 10 pies to cover packaging, leakage, Sale Commission and other miscellaneous charges thus making a total of 11 annas a gallon for the consumers to pay. If the Power Alcohol be saved from Excise duty of 2 annas and 9 $\frac{1}{2}$  pies a gallon it would compete nicely with Kerosene in any part of India and may eventually drive out Kerosene entirely; otherwise the State must subsidize to the extent of 2 annas for every gallon of Power Alcohol that may go to replace Kerosene. To begin with, campaign must be started in large towns and district headquarters and at the same time making it compulsory as far as possible for all Government purposes, District Boards and Municipal Institutions, the use of Power Alcohol in place of Kerosene. A moderate programme on all India basis to replace say 10 per cent. (150 million gallons) of our present Kerosene consumption for illuminating purposes, with Power Alcohol should be undertaken.

8. The balance of 32 million gallons of Kerosene used for Power purposes will be easier to replace with Power Alcohol, because the consuming units are larger and mainly employed by Municipal Water Works, Workshops, and small industries as well as for power farming. Germany has made the best progress in the design and manufacture of Alcohol engines for various industrial and Agricultural uses. Certain types of engines can be operated with petrol, Kerosene or Alcohol, simply by reducing the clearance space in the cylinder for proper compression. The feeding or carburetting devices require very little change.

9. Alcohol Engines for land and marine service, Alcohol Tractors, Alcohol Locomotive for use in Forests, Mines, quarries and in large agricultural estates, are widely used in all countries lacking Petroleum resources. Germany as far back as 1902. consumed yearly 20 million gallons of Alcohol for Power and industrial purposes. It is estimated that according to the proposed scheme, consumption under this head will reach 7 million gallons a year. Question of fuel oil though an important item on India's import list, has to be left over till the other Power Alcohol programme, as outlined in this scheme, is well on its way to completion.

10. *Five-year plan*—Subject-matter discussed above relates to an all India problem and calls forth for the progressive development of Power Alcohol Industry that will in its fifth year of growth, reach a figure of 60 million gallons to replace imported petrol and Kerosene as summarized below :

TABLE II

Type fuel	Per cent. alcohol	Power alcohol, 1943-44
<b>Petrol replacement—</b>		
Mixture A .. .. .. .. ..	25	12,500,000
" B .. .. .. .. ..	50	20,000,000
" C .. .. .. .. ..	100	5,005,000
<b>Kerosene replacement—</b>		
Illuminant .. .. .. .. ..	100	15,000,000
Motive power .. .. .. .. ..	100	7,000,000
Total (Power Alcohol) .. ..		60,000,000

It is difficult to fix at this stage the rate of Alcohol production from year to year, but it may be taken as certain, that if the Provincial Councils pass the necessary legislation for the Alcohol Petrol Mixtures and there be no serious oppositions from the Government of India and the vested oil interests the contemplated five years plan for making available early 60 million gallons of Alcohol, would finish long before the scheduled period.

Our total Alcohol capacity of 60 millions gallons will be split up into six units each with a yearly capacity of about 10 million gallons and each consuming nearly 170,000 tons of Indian Molasses. Starting with one unit and as the scheme develops along, similar units at suitable centres will be installed throughout India.

11. *State control*—If the Power Alcohol Industry is to be developed in India, it is absolutely essential to do the same under strict State Control and protection. And the national significance of this problem can be better

judged from the letter quoted below, addressed by a French Senator to Clemenceau on 12th December, 1919 :

" He who owns the Oil will own the World, for he will rule the sea by means of the heavy oils, the air by Petrol and the illuminating oils and in addition to this he will rule his fellow men in an economic sense by reason of the fantastic wealth he will derive from oil the wonderful substance which is more sought after and more precious today than Gold itself."

To give an instance of an economic rate war, it may be stated that for considerable number of years, the Standard Oil Company of America used to regard India and China as its own preserve. The Company distributed at first gratis, and afterwards at half the cost price, lakhs of cheap Kerosene Oil lamps bearing the inscription " Good Luck." As British Dutch-Shell came on the scene she was able to sell the Chinese its oil at a price considerably below that which the Americans could afford to do, Sumatra being nearer than California. By 1911, however an agreement was made between the two Companies by which 50 per cent. of the East Asiatic market, was handed over to Royal Dutch. Recently Bombay City experienced a similar economic war in case of Petrol, Burma-Shell driving out the Russian Petrol.

Since 1911-12, oil economic fight has developed into a political fight and the struggle for oil is being fought out today, and will be carried on tomorrow, as fiercely as ever. Before the war, i.e. 1913, British Empire produced 2 per cent. of the World's total production of oil, while at present she controls at source over 20 per cent. of World's total production. This was made possible because of continued State help and protection to British oil trading interests. This business venture on the part of the British Government has proved very profitable. The original investment of £2·2 millions made by the British Parliament in 1914, has now become £60 millions. This British control over Anglo-Persian and Burma-Shell groups is no less valuable to Great Britain today than her control over the Suez Canal.

India's case is somewhat comparable to France and Germany, because the latter two countries do not possess any more natural oil resources than India. It is natural therefore that France's production of Power Alcohol should be the highest (88 million gallons) and Germany coming next with an annual production of 48 million gallons and the entire trade of Power Alcohol and Petroleum Imports in the two countries is regulated under State control and supervision.

Fortunately, circumstances at present are most favourable for India to develop the Power Alcohol Industry. There is nationwide demand for it, and the enormous quantity of waste Molasses will be put to use. Capital and Copper are available at cheap rates. The oil companies who are busy supplying the European Countries for storing enormous quantities of petrol, for defence purposes, would not mind a little shrinkage in their Indian business. And above all, Government of India, seems to be in a reasonable mood and most probably will not let down the Provinces, in trying out the economic efficiency of the new constitution. It is essential, therefore, that the bill for the compulsory mixing of Power Alcohol with Petrol be passed by the Provincial Legislators. The Honour and National responsibility however, for starting the Power Alcohol Industry will primarily rest with the United Provinces and Bihar Governments and in all respects the two Provinces are admirably suitable to shoulder the undertaking.

12. *State funds*—To make the enterprise of such a magnitude a success, an efficient organization and large funds would be necessary. Although the initial heavy capital investment and working capital would be entirely provided by the public, still the State must incur a heavy annual expenditure to fulfil her part of the obligation, which may take the form of subsidies, guarantee on the capital investment, establishing a Technical Institute and providing transport and other facilities in order to stabilize the Industry.

Considering the present state of provincial finances, it is doubtful if large funds would be available for establishing the Power Alcohol Industry. Therefore, it is proposed that in the interest of the Industry and the public at large, the State should raise the money in the following manner and earmark the same as an "All India Power Fund."

(a) *Molasses Cess*—It is proposed to levy a sale tax of one anna per maund on all factory molasses sold. The consumers and exporters, at present are paying very little for the molasses and they will certainly not grudge paying some cess so long the price of molasses does not exceed Re.1 per maund, which is the prevailing price in countries like England, America, etc. Molasses from Gur Refineries and Khaudsars amounting to 144,000 tons a year should be exempted from the Cess, because on account of their better quality and taste are found excellent for tobacco curing and making Cattle Fodder. Factory Molasses amounting to 410,000 tons a year will yield an income of Rs.7 lakhs, of which the United Provinces will contribute Rs.4 lakhs, Bihar Rs.2.25 lakhs and the rest of India Rs.0.75 lakh only.

(b) *Petrol Cess*—It is proposed to levy a sale tax of annas two per gallon on all straight Petrol and Mixture sold throughout India, which according to our present rate of consumption and as stated in Section 8 above, comes to 50 million gallons, while Mixture B will carry no tax. Mixture C on the other hand shall receive State help of annas two per gallon and under the proposed scheme as outlined in Section 10 only 5.5 million gallons of Mixture C will be marketed. Similarly Power Alcohol replacing Kerosene when used as illuminant or motive power will receive a State aid of annas two per gallon. After adjusting the State subsidy on 27.5 million gallons of National Fuel (100 per cent.) Power Alcohol, the Petrol Cess will leave a favourable balance of Rs.28 lakhs a year. The State policy behind the above taxation measures shall be two-fold: first to make the new Power Alcohol Industry self-supporting from its very start and secondly to encourage the use of National Fuel at the expense of Foreign Petrol. How this large sum of Rs.35 lakhs a year be incurred will largely depend upon the State Policy pursued and details in this connexion will have to be worked out by the proposed Alcohol Board of which a bare outline is given below.

13. *State Organization*—An Alcohol Board will be constituted on an all India basis, each province co-operating in the scheme will nominate one outstanding industrialist. These eleven members in turn will nominate four Technical Experts thus increasing the Board's strength to fifteen. The Board shall be vested with full and final authority on all matters concerning the development of Alcohol Industry and its progress and competency will be judged by its completing in time the five years plan as outlined in Section 10. The life of Board's member will be for five years but each Provincial Government will be free to recall its member and send in a substitute. All the 15 members of the Board shall be honorary but they will be paid first class travelling allowance plus Rs.100 for attending every meeting of the Board. The Secretary of the Board will be a permanent paid officer, assisted by several Under Secretaries representing various departments like,

Production, Alcohol Institute; Publicity; Excise; Power Farming, etc. It is estimated that the Board's establishment alone will cost Rs.6 lakhs a year.

Alcohol Institute will be established to carry on Industrial Research Work in co-operation with the Production Units and to introduce such Alcohol bearing products as described in Part II of this scheme. The Institute will be under the control of a Director, directly responsible to the Alcohol Board. It will have three co-ordinated Sections, viz. Chemical, Biological and Engineering. As to what Chemical research can do to establish an industry may well be illustrated by citing the case of American Alcohol Industry. With the advent of prohibition most of the distilleries were closed down thus effecting the agricultural interests very badly. To overcome this difficulty and to put back into service huge dead capital both the State and the Industry requisitioned the services of Research Chemists to find new outlets for Alcohol, with the result that in a few years' time the American Alcohol Industry was raised to a place of first importance and now the total United States Production of Industrial Alcohol, in the year 1937, reached 100,000,000 wine gallons, (100 per cent.) which was entirely absorbed by the various chemical industries like Chemicals, Drugs and Pharmaceuticals, Toilet preparations and Plastics, etc. Thus it was made possible to consume annually all the molasses available and in addition one lakh tons of Corn giving considerable relief to the American Agriculturists. Following the same policy of development we should find no difficulty in raising our annual consumption of Industrial Alcohol to 20 million gallons by the end of our five-year plan. The Chemical and Biological Sections will also be concerned in problems involving the recovery of fertilizers and other by-products like CO<sub>2</sub>. Yeast and cheap denaturants. Till the Institute's own buildings are ready it will be accommodated in the Works Laboratories adjoining the first Central Distillery. The main Institute's buildings, staff quarters, laboratory equipment and fittings, various Pilot plants including steam and Power plant will cost nearly Rs.10 lakhs. And in order to finish the five-year plan in time and to build the Industry on strong chemical foundations and in order that the Institute's work be carried on the basis of International Co-operation involving exchange of research problems, Patents, etc., the annual recurring expenditure will amount to Rs.9 lakhs.

The Publicity and the State Aid departments working under the control of the Alcohol Board will by far play the most conspicuous rôle in shaping the success of the scheme. While it will be an easy matter to dispose off 88 million gallons of Power Alcohol as Motor Fuel with the help of Government Legislation, it would, on the other hand, require a well organized nationwide propaganda backed by a powerful sales and engineering service to market the balance of 22 million gallons of Tax-Free Power Alcohol which will be used in place of imported Kerosene for illuminating and motive power purposes. It shall be the primary duty of the Publicity Department to make the name of Power Alcohol or any other name given to this National Fuel like Qaumi Tail, a household word and make such arrangements that its availability is made as easy as that of wood, coal or kerosene. To replace 15 million gallons of imported Kerosene with Power Alcohol would mean putting into service 75,000 Alcohol Lamps a year for five years at about half the cost price and mainly manufactured in India. This is, based on the assumption that a 30 candle power Alcohol lamp as supplied by the Publicity Department will burn on an average 8 hours during night time throughout the year. Some liberal policy will be adopted towards the supply of Alcohol Tractors and pumping sets run by Power Alcohol. All farm machinery ordered by the Co-operative Societies and Collective Farms throughout

India will be supplied at half the initial cost. The Engineering Section of the Institute will look after the demonstration and will render all possible service to the users of machinery run on Power Alcohol. State aided Automobile garages will render free service to trucks and buses using 100 per cent. Power Alcohol Motor Fuel. It is estimated that this department will cost approximately Rs.15 lakhs a year. The balance of Rs.5 lakhs will be taken up by the Excise Department and maintenance of other administrative machinery working under the control of the Alcohol Board.

14. *State Legislation*—The right thing would be that all the Provinces in a body approach the Government of India to pass the necessary legislation for compulsory mixing of Power Alcohol with imported or indigenous Petrol and take up the development of the Alcohol Industry on all India basis. If the concerted attempt fails in that event each Province should pass the necessary legislation and co-operate with other provinces in a manner that may set the organization going country-wide. Framing of the new Alcohol Act is a matter of details and can be drafted on uniform lines after the provinces have declared their intention of joining the scheme. As a matter of fact, the molasses problem, as well as the more important question of National Fuel will not be solved satisfactorily unless the problem is tackled on an All India basis.

As the proposed scheme will be developed in stages, it is recommended that there should be six central distilleries each with a daily capacity of 30,000 gallons of alcohol, thus bringing the annual production to 60 million gallons of Power Alcohol by the end of fifty year. Eventually each province will have one or more central distilleries most economically located to meet all their requirements of Power and Indian Alcohol. That the two Governments of the United Provinces and Bihar are seriously faced with the problems of disposing of large quantities of surplus molasses, makes it imperative on the part of the two Governments to start the first central distillery at a place conveniently located in respect of two Provinces and the most suitable place thought of from all economic considerations is " SONEPORE." What follows hereafter, therefore, shall relate to our first unit Central Distillery at Sonepore sponsored by the Governments of the United Provinces and Bihar and it is hoped that before placing order for the second unit, the All-India Organization and other State control measures will be perfected.

15. *Sonepore*—Chief factors discussed below in order of importance, that should determine the location of any Power Alcohol Central Distillery are :

- (a) Molasses supply,
- (b) Transport facilities.
- (c) Coal fuel.
- (d) Fresh Water Supply.

(a) *Molasses*—Sugar factories areas in which molasses is in most distressed state are : North Bihar and District of Gorakhpore, comprising nearly 56 sugar factories. It is from this area that the Indian Molasses Company of Great Britain purchases its supplies for export purposes. This Company has its storage installation at Sonepore and hauls the molasses in tank wagons from the neighbouring factories, situated on the B. & N. W. Railway line. The Company buys molasses at a ridiculously low price of annas 1-3 per matund and pays on the average anna 1 per matund as railway freight up to its storage installation at Sonepore. It costs another 1 anna

3 pies per maund to take the same by boat to Calcutta and the pumping charges at Calcutta come to 6 pies per maund thus bringing the cost up to 4 annas per maund before the Cargo Steamer leaves for Europe. If the ocean freight be taken at 4 annas per maund and following anna 1 per maund as Dock Charges on the other end, it costs the Indian Molasses Company a minimum of annas nine (-/-/-) per maund to land molasses in Great Britain. The overhead expenses are so high that the Company hardly makes anything by selling at 11 annas per maund. The Continental price is annas 12 per maund and the Cuban molasses today are fetching 14 annas a maund delivered in America, where the price prior to 1929 used to be Re.1-4 per maund. The Export Molasses scheme has proved a failure, as in the year 1936-37, the export amounted to 34,000 tons only, out of 350,000 tons of available surplus. Under the proposed scheme the entire molasses production will come under the control of the Excise and Prohibition Department and its marketing will be controlled by the Alcohol Board. The Alcohol Board shall fix the basic minimum price of 4 annas per maund at any Sugar Factory and after paying the Cess of 1 anna per maund and another 1 anna per maund at railway freight, it will cost the Central Distillery 6 annas per maund of molasses delivered.

As to the availability of molasses near Sonepore there are 17 factories in North Bihar that are within 200 miles of Sonepore, while 26 factories in the District of Gorakhpur, United Provinces, are situated within 200 miles of Sonepore. In all there are 40 sugar factories with a total annual production of 200,000 tons of molasses which lie within the economic distance (i.e. one anna per maund railway freight) of Sonepore. The proposed distillery, however, when working at full capacity will consume 170,000 tons of molasses a year producing 10 million gallons of Power Alcohol. Sonepore therefore occupies the best position in the whole of the United Provinces and Bihar as a molasses centre.

(b) *Transport Facilities*—We have already stated the railway facilities existing for the transport of molasses to Sonepore and the same service will be utilized for the distribution of Power Alcohol and other products in the markets of North Bihar and Eastern parts of United Provinces served by the B. & N. W. Railway and R. & K. Railway. Across the river, is the broad gauge State Railway—E. I. Railway, running from Calcutta to Delhi. The unique transport feature in favour of Sonepore is the existence of Ganges and Gauges transport service as far as Calcutta and it is no exaggeration to state that this feature alone should make Sonepore in the near future, a highly industrialized area. Water freight rate comes only to a fraction of what it costs to transport either by rail or road. For instance railway freight on Petrol from Calcutta to Patna is 1 anna 3 pies a gallon, when carried in tank wagons of 5,000 gallons. On the other hand to cover the same distance either way by a small steam boat and trailers it will cost at the most 3 pies a gallon and if there be no transhipment, another 3 pies a gallon will carry Power Alcohol from Calcutta to any Indian port like Madras, Bombay, Karachi, etc. There are enormous commercial possibilities if the Inland Indian Waterways be properly developed and the two Governments of the United Provinces and Bihar will do well to appoint a Joint Commission to investigate further development of river transport in the two Provinces. A Central Distillery at Sonepore will be ideally situated and may be compared well to a steam Power Plant installed at the mouth of a Coal Mine Pit, supplying current to large towns by a long distance transmission system.

(c) *Coal Fuel*—The proposed Distillery will consist of several units capable of producing annually 8 million gallons of Power Alcohol and 2 million gallons of Industrial Alcohol, the latter will be used in the manufacture of solvents and other Alcohol products as described in Part II of this scheme. Taking 333 working days in a year, it will come to 30,000 gallons of Alcohol a day of 24 hours. Steam consumption will be 35 lb. per gallon of Power Alcohol made, but taking into consideration other Power requirements, the powdered coal fired steam Power Plant will be designed at normal rating, on the basis of 40 lb. steam per gallon of Alcohol made. This means a daily consumption of 1,200,000 lb. of steam. Taking the average heat value of Bihar coals as 11,000. B. T. U. per lb. of coal and assuming an over all heat efficiency of 65 per cent., we will produce 6 lb. of steam per lb. of coal burnt or a consumption of about 90 tons of coal per day of 24 hours. Another 15 tons a day will be consumed by Railways and Steamships for the transport of molasses, Power Alcohol and other products. Sonepore is within easy reach of Bihar Coal Mines and by combining the Rail and River Transport Service and entering into long term coal supply contracts the fuel bill will be cut down considerably thus making appreciable contribution towards lowering the cost of Power Alcohol. Low pressure steam is used in the distillation and evaporation processes, therefore, two non-condensing extraction Turbine sets will be installed to generate current and supply processes steam at the desired low pressure. By this arrangement we shall have a large surplus of electric current available costing only one pie per unit.

(d) *Water Supply*—Distillation processes require large quantities of fresh cooling water for the condensation of vapours, therefore Central Distilleries in general are located on sea-boards or large river heads. About 10 gallons of cooling water per gallon of Power Alcohol made is considered sufficient with a properly designed plant, but certain allowance must be made in case of tropical countries like India. In case of Sonepore, it would be safe to take 50 gallons of cooling water per gallon of Alcohol made. On this basis, the proposed unit will require 1,500,000 imperial gallons of cooling water a day. Fortunately the Gandak and the Ganges are big enough to meet requirements. With current costing, one pie a unit, our pumping costs will be kept at minimum.

Not a single distillery out of existing ones now working in United Provinces, Bihar or in any other part of India can offer such decided advantages as described above pertaining to Sonepore. The existing distilleries are not only small but too obsolete units to deserve any economic consideration under the present scheme.

16. A careful survey, however, of the Sonepore area, shall have to be made before it could be decided to select a suitable site that may be free from any possibility of floods. The survey work by the prospecting company should start immediately and continue throughout the coming rainy months. The entire plant, however, will rest on a concrete pile foundation and entirely built on concrete and steel to withstand earthquake shocks and to be safe from minor sub-soil disturbances. Should any difficulty arise in finding a suitable site at Sonepore, the next best place would be across the Ganges lying between Digha-Ghat and Dinapur. The molasses, etc. could be ferried or piped across the river.

**MANUFACTURE:** In dehydrating Alcohol, i.e. producing a water-free Alcohol, known as Power Alcohol, such as is now required for motor

fuel, the azeotropic process which is the oldest and more economical than the salt process is generally used. For climatic conditions as prevailing at Sonepore, average Alcohol yield in an azeotropic process would be 98.5 per cent. and Benzol consumption of 0.004 gallon per gallon of Power Alcohol produced. Benzol solvent, which will be required for the manufacturing process, as well as for denaturing purposes, if not already available in India, will be recovered from the existing coke ovens, thus establishing another important industry from industrial waste.

It would cost 4 annas to manufacture a gallon of rectified spirit of 95 per cent. strength, and its summary analysis is given in Part II. We are now concerned to calculate the over all cost of a gallon of absolute alcohol of 99.97 per cent. strength, manufactured in a distillery five times the capacity, and employing azeotropic process. The molasses price is to be taken at annas 6 per maund at the distillery, yielding 2.1 imperial gallons of Power Alcohol of 57 gallons of Power Alcohol per ton of molasses. The molasses charge per gallon of Alcohol will come to 2 annas 9 pies. The total investment on the proposed distillery producing 30,000 gallons alcohol a day will amount to Rs.30 lakhs. Taking plant depreciation and insurance at 7 per cent. the annual amount comes to Rs.2.1 lakhs or a charge of 4 pies per gallon. Labour charges and staff salaries for the said Central Distillery will not exceed Rs.1 lakh annually or a charge of 2 pies per gallon. As to steam and power charges, we are taking a liberal estimate of 40 lb. steam consumed for every gallon of Power Alcohol produced, which when rendered in terms of coal means 4.5 lb. of coal, and assuming coal cost at Rs.10 per ton delivered at Sonepore, the Fuel cost per gallon of alcohol will not exceed 4 pies. Taking 0.004 gallon benzol per gallon of power alcohol produced, the daily benzol consumption will not exceed 100 gallons or Rs.100 a day. After making a liberal allowance for the consumption of other stores, chemicals and supplies, the total annual bill will not exceed Rs.1.5 lakhs a year or a charge of 3 pies per gallon of produce. Overhead and establishment charges will amount to Rs.1.5 lakhs a year or a charge of 3 pies per gallon. The excise supervision and direction will take another Rs.50,000 a year or 1 pie per gallon. Alcohol loss due to leakage and evaporation being transhipment to petrol bulk installations is taken at 1 per cent. by volume, and fire insurance at 2 per cent. on stock value of 1 million gallons, thus the combined charge per gallon will not exceed 1 pie which comes to over Rs.50,000 a year. The above items are summarised below:

TABLE III

Item	Per gallon		
	Rs. a. p.		
Molasses cost at -/-/- per maund	..	..	.. 0 2 0
Plant Depreciation and Insurance	..	..	.. 0 0 4
Labour charges and staff salaries	..	..	.. 0 0 2
Steam and Power Costs	..	..	.. 0 0 4
Benzol, Chemicals and Stores	..	..	.. 0 0 3
Overhead and establishment	..	..	.. 0 0 3
Excise supervision and direction	..	..	.. 0 0 1
Evaporation loss and fire insurance	..	..	.. 0 0 1
Total	..	..	.. 0 4 3

Therefore, the actual cost of manufacturing Power Alcohol comes to 4 annas 3 pices per imperial gallon, including evaporation losses during transport up to mixing installations. Of this 2 annas 9 pices or 65 per cent. of total cost represents the cost of molasses and the balance 1 anna 6 pices or 35 per cent. as the manufacturing or conversion charge. In other words on one year's production, the Central Distillery shall pay Rs.11 lakhs for molasses; Rs.2.1 lakhs for coal and Rs.3.2 lakhs in the form of wages and salaries. By increasing the distillery capacity five fold, it has been made possible to reduce the manufacturing charge from 4 annas to 1 anna 6 pices per gallon. If the markets for the distillery products such as Dry Ice, Yeast, Fertilizers and surplus electric energy be properly developed, the extra profits from such sales would be more than sufficient to absorb the entire manufacturing charge of 1 anna 6 pices a gallon, thus bringing down the cost of Power Alcohol to 2 annas 9 pices a gallon barely to cover the cost of molasses only. The great strides made by the chemical and its economic success abroad is mainly due to the inter-department development of basic chemical industries in which a waste product of one industry, invariably forms a valuable raw material for another one, thus helping each other to reduce the over all manufacturing costs.

17. *Marketing*—The proposed unit at Sonepore will produce annually in the first instance, 8 million gallons of Power Alcohol; 2 million gallons of Industrial Alcohol in the form of Alcohol bearing chemical products and Potash and Ammonium Sulphate fertilizers to the extent of 16,000 tons and these products will have an annual market value of Rs.40 lakhs, Rs.50 lakhs and Rs.20 lakhs, respectively. With the completion of the five year plan the annual production will reach 60 million gallons of Power Alcohol, 5 million gallons of Industrial Alcohol and 32,000 tons of Fertilizer and at the present prices the annual production will amount to nearly Rs.5 crores. To distribute and market these products an efficient organization independent of Petrol distributing companies would be necessary. The said company will be one of the service units of the parent company and shall look after the transport, storage and supply of Power Alcohol from Central Distilleries like Sonepore to various Petrol bulk installations. If found necessary the company shall also provide facilities for the mixing of Power Alcohol with Petrol and shall establish service station, warehouses and sales offices for the mixture C and other Alcohol products described in Part II of this scheme.

To start with, the entire production of 8 million gallons of Power Alcohol will be marketed in the five provinces: Bengal, Bihar, Orissa, United Provinces and Central Provinces with an annual Petrol consumption of 34.5 million gallons. Should any difficulty arise in case of Bengal, in that event Madras or Bombay may be taken as substitute but it is very important to include one of the Port towns for marketing Power Alcohol. It is proposed to absorb 3 million gallons of Power Alcohol in the form of Mixture A containing 15 per cent. Alcohol only, another 4 million gallons of Power Alcohol in the form of Mixture B containing 30 per cent. Alcohol only and the balance of 1 million gallon of Power Alcohol will be consumed in the form of Mixture C or straight 100 per cent. Power Alcohol. No adjustment, whatsoever, either in the carburettor or in any other part of the Motor Engine would be necessary using above mixtures. With increased production of Power Alcohol either its percentage in the above mixture be increased or low Alcohol mixtures be introduced in new provinces.

In addition to the existing railway transport facilities and the proposed inter-provincial motor transport a national waterways transport company will be organized to cover the navigable portions of the rivers: Ganges, Sone, Gandak and later on extend traffic along Jumna and Gogra rivers. This will serve most of the commercial towns in United Provinces, Bihar, including Calcutta Port; further joining the Indian Coastal traffic, will serve the parts of Madras and Bombay. After working out the details and considering the economies effected by co-ordinating the three transport services, it has been possible to prepare the following table giving approximate average prices that the consumer will have to pay for a gallon of Power Alcohol at the service pump in the said five provinces:

TABLE IV

Item	Bengal	Bihar	Orissa	United Provinces	Central Provinces
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
Power Alcohol cost ..	0 4 3	0 4 3	0 4 3	0 4 3	0 4 3
Denaturing charges ..	0 0 8	0 0 8	0 0 8	0 0 8	0 0 8
Profit 10 per cent. ..	0 0 6	0 0 6	0 0 6	0 0 6	0 0 6
Transport up to mixing department.	0 0 6	0 0 7	0 0 9	0 1 3	0 1 0
Mixing charges ..	0 0 2	0 0 3	0 0 4	0 0 5	0 0 6
Distribution ..	0 0 6	0 0 7	0 1 0	0 1 0	0 1 3
Retail commission ..	0 1 0	0 1 0	0 1 0	0 1 0	0 1 0
Transit loss 100 per cent. ..	0 0 3	0 0 3	0 0 3	0 0 3	0 0 3
Excise ..	0 10 0	0 10 0	0 10 0	0 10 0	0 10 0
Total ..	1 1 10	1 2 1	1 2 9	1 3 4	1 3 11
Provincial tax ..	0 2 0	0 2 0	0 2 0	0 2 0	0 2 0
Sale price ..	1 3 7	1 4 1	1 4 9	1 5 4	1 5 11
Petrol price, past 3 years' average	1 4 7	1 6 0	1 7 0	1 8 0	1 8 0

As the percentage of Power Alcohol in Mixture A is much smaller of the two, it would be necessary to leave the mixing and the subsequent distribution of the mixtures in the hands of the existing oil distributing companies. Therefore the price of Power Alcohol for all practical purposes of this scheme should be reckoned, delivered at the various mixing Depots located at Ports or in the interior. Table IV above shows that we are in a position to market Power Alcohol in the said five provinces at prices lower than Petrol, when averaged over last three years. Recently, however, due to rate war with "Caltex", Petrol prices at Calcutta has dropped to Re.1-2 a gallon and it may still go down to the level of Bombay where due to competition from Russian Petrol, its price stayed at 15 annas a gallon for about 4 years but recently it has again come up to Re.1-2 a gallon. Under the present scheme, however, we are in a position to market Power Alcohol in Madras and Bombay Presidencies at Re.1-2-6 and Re.1-3 a gallon respectively, delivered at their Port mixing depots.

Power Alcohol sold even at a little higher price for mixing purposes will not make appreciable difference in the ultimate price of mixture. This point is properly analysed in Table V below :

TABLE V

	Petrol	Power Alcohol	10 per cent.	15 per cent.	20 per cent.	25 per cent.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
I	1 0 0	1 4 0	1 0 4.8	1 0 7.2	1 0 8.6	1 1 0
	1 0 0	1 8 0	1 0 9.6	1 1 2.4	1 1 7.2	1 2 0
	1 0 0	1 12 0	1 1 2.4	1 1 9.6	1 2 4.8	1 3 0
II	1 2 0	1 4 0	1 2 2.4	1 2 3.6	1 2 4.8	1 2 6
	1 2 0	1 8 0	1 2 7.2	1 2 0	1 3 2.4	1 3 6
	1 2 0	1 12 0	1 2 11.5	1 3 6	1 4 0	1 4 6
III	1 4 0	1 4 0	1 4 0	1 4 0	1 4 0	1 4 0
	1 4 0	1 8 0	1 4 4.8	1 4 7.2	1 4 9.6	1 5 0
	1 4 0	1 12 0	1 4 9.6	1 5 2.4	1 5 7.2	1 6 0
IV	1 6 0	1 4 0	1 5 9.6	1 5 8.4	1 5 7.2	1 5 6
	1 6 0	1 8 0	1 6 2.4	1 6 3.6	1 6 4.8	1 6 8
	1 6 0	1 12 0	1 6 6.5	1 6 10.8	1 7 2.4	1 7 6

Again the price of Power Alcohol should not be governed by the market price of Petrol which is largely controlled by the oil companies. Its price on the other hand should be regulated by the agricultural interests affected and be left to the authority of the Government Alcohol Board who will take into consideration various economic and national Factors when fixing the price of Power Alcohol. The price however, may include a charge of 2 annas a gallon as Provincial excise duty, which at the completion of five-year plan will yield an annual revenue of Rs.75 lakhs distributed amongst different provinces in proportion to their Power Alcohol consumption. This excise duty, however, should not be mixed up with the molasses and Petrol cess stated in paragraph 12; while the former will contribute towards provincial finances, the latter on the other hand shall provide funds for the development and maintenance of the Power Alcohol Industry.

Figures contained in Table IV and Table V show that the manufacture and marketing of Power Alcohol is an economic feasibility. Given a fair chance the proposed scheme guarantees to supply to the consuming public, a national Fuel, at price, no higher than the Petrol price when averaged for the last three years. While affording substantial relief to the Sugar Industry, Power Alcohol will go a long way in stabilizing Petrol prices throughout India, thus restricting the monopolistic tendencies of the Oil Companies. All this will be made possible by a suitable legislation for compulsory mixing of Power Alcohol with Petrol and development of its trade as compatible with the national interests.

18. *Capital Investment*—The proposed central Distillery with a daily capacity of 24,000 imperial gallons of Power Alcohol, inclusive of all machinery, Power Plant, Buildings completely installed would cost

approximately Rs.30 lakhs. Taking 333 working days in a year, production will amount to 8 million gallons and allowing only half an anna a gallon as net profit the annual minimum return will amount to Rs.2.5 lakhs or 8.3 per cent. on the capital investment. This, however, does not include any profit that will accrue from the recovery of fertilizers, dry ice, and from the disposal of yeast products. Recovery of by-products is treated separately in Part III and would yield higher returns on the investment. The business of manufacturing Power Alcohol will be organized as a Joint Stock Company and the Provincial Governments concerned shall guarantee for a period of 5 years a return of 4 per cent. on the total share capital invested.

For the marketing of Power Alcohol and other Alcohol products a separate organization to do the transport and selling would be necessary. This company will be a subsidiary concern but governed by the same Board of Directors and guided by All-India Power Alcohol Board. The company being assured of business shall not stand in need of any Government subsidy or guarantee on the capital lay-out. Most of its capital investment will be utilized in the purchase of steam boats, tankers, Alcohol trucks and in organizing the sale and distributing of straight Power Alcohol. This business would require a capital lay out of Rs.25 lakhs yielding a minimum return of 15 per cent.

19. *Summary*—My conclusions and recommendations are summarized below—

(1) In the year 1936-37 Indian production of molasses amounted to 550,000 tons of which 350,000 tons were available as surplus. Average price realized was 1 anna 6 pies a maund while the proposed scheme assures a minimum price of 4 annas a maund thus benefiting the sugar industry and the cane-grower to the extent of Rs.23 lakhs a year.

(2) In five years' time the scheme is capable of replacing 38 million gallons of Petrol and 22 million gallons of kerosene, with Power Alcohol. To start with, the Sonepore Unit will manufacture 8 million gallons of Power Alcohol consuming 140,000 tons molasses annually.

(3) A judicious mixture of Power Alcohol, up to 25 per cent. with Petrol makes a better fuel for automobiles, requiring no change in the adjustment of the Engine or Carbureitor. A 50—50 mixture will burn satisfactorily in motor lorries and buses. Straight Power Alcohol can be used in certain types of engines, tractors and other agricultural and mining machinery.

(4) Power Alcohol, manufactured by this Azeotropic process, will cost 4 annas and 3 pies per Imperial Gallon. Of this 2 annas and 9 pies represents the cost of molasses at 6 annas a maund and the balance 1 anna and 6 pies as the manufacturing charge. Allowing on a gallon 6 pies as profit, 8 pies as denaturing charge and 10 annas as excise, Power Alcohol can be delivered to any mixing depot in India at an average price of Re.1-1-6 a gallon. The combined charge for mixing, distributing and transit loss will come to 2 annas 6 pies a gallon, thus bringing the average retail price, on all-India basis, to Re.1-4 against Re.1-7 of Petrol when averaged over the past three years.

(5) Power Alcohol can compete with Petrol and Kerosene without a subsidy from the Government. Necessary legislation, however, must be enacted for the compulsory mixture of Power Alcohol with Petrol. Besides paying its own establishment charges, the Industry can become a good

source for raising Provincial revenues as slight increase in Power Alcohol price will not affect appreciably the price of mixture.

(6) Alcohol Industry like many other agricultural industries such as sugar, textile, jute, vegetable oils, etc. is an important key industry especially in the chemical field and it must be developed on all India basis. The two Provinces most suitable for its establishment are United Provinces and Bihar. Sonepore locality satisfies most of the requirements of a Central Distillery.

(7) Sonepore Distillery with an annual capacity of 8 million gallons of Power Alcohol will cost Rs.30 lakhs, yielding a minimum return of 8·3 per cent. The investing public should be protected by the Provincial Government by exercising price control and guaranteeing 4 per cent. on the capital investment for five years.

(8) A subsidiary transport and distributing company shall be organized to carry Power Alcohol from the Distillery to all storage and mixing Depots which are owned by the existing Petroleum companies. A flat rate of 2 annas and 1 pie a gallon will be paid for this service. This company would require a capital layout of Rs.25 lakhs yielding a return of 15 per cent. Mixing and distributing of mixture to service pumps will be left to the existing Petrol distributing companies allowing them a fixed charge of 2 annas and 6 pies a gallon inclusive of 1 anna as retail commission.

(9) The denaturant used will be either 5 per cent. Benzol or 2½ per cent. wood Naphtha by volume, thus the denaturing charge will come to 8 pies a gallon. The use of such denaturants will result in the establishment of Benzol Recovery and Wood Distillation Plants.

(10) On the completion of five years plan, we would be consuming 60 million gallons of Power Alcohol instead of imported Petrol or Kerosene Oil, thus saving annually Rs.250 lakhs from going abroad. This will also make possible the manufacture of Industrial Alcohol Chemicals and Fertilizers as outlined in Part II and III of this minority report. The Alcohol industry will primarily benefit the Indian Agriculture, partly solve the question of National Fuel and give substantial relief to the problem of unemployment.

## PARTS II and III

## UTILIZATION OF MOLASSES

1. With the fast development of Indian Sugar Industry, the disposal of molasses has become a problem, and with its increased production every year and no outlet for its consumption, it is having serious repercussions on the Industry. The most popular method, which at the same time is free from technical difficulties, is to ferment molasses into Alcohol, and use the same as Motor Fuel. Most of the countries that lack petroleum resources, use Power Alcohol as a substitute. This however, is only possible under Government protection and control and there is no reason why the Government of India should not pass such a legislation, providing compulsory mixing of Alcohol with the imported Petrol.

2. Besides the Power Alcohol question, various other proposals have been advanced from different quarters, in the past five years, suggesting the use of molasses as Fertilizer, Cattle-Food, Fuel, Road Surfacing, etc., but none of these has met with any appreciable measure of success in solving the molasses problem. The proposed scheme will be a new departure in India, as far as the treatment of molasses is concerned. It calls for immediate establishment, either in United Provinces or Bihar, of a highly technical and specialized Alcohol-Chemical Industry, on lines as it is being practised today in many countries abroad. This scheme has nothing to do with the Power Alcohol, on the other hand, after fermenting molasses into Alcohol, it destroys Alcohol converting the same into commercial products that have a ready market in India.

3. In the Western Countries, Alcohol is looked upon as an Agricultural product, as it is chiefly manufactured from potatoes, cereals, molasses, etc. In the interest of Indian Agriculture, it is essential that new uses should be found for molasses, which is an important large scale by-product of the second biggest national industry. If such uses have an economic foundation and will thereby bring an extra return to the Industrialist it is only reasonable to expect that he will pass on a part of these returns to the cane grower. Industrial Alcohol will be produced from Molasses for use in various small scale industries and in the manufacture of other Alcohol products. The by-products of an Industrial Distillery such as Carbon Dioxide Gas, Cattle Food, Potash and Ammonia Fertilizers, etc. will also be of great benefit to the Indian Agriculture.

4. As Molasses form the basic raw material of this scheme consideration of its supply is of primary importance; it is estimated that factory sugar production for the year 1936-37 exceeded 1,000,000 tons, and molasses obtained amounted to nearly 450,000 tons. Of this figure, United Provinces, is responsible to the extent of 55 per cent. and Bihar 30 per cent. This figure does not include molasses from Khandasars. Allowing 100,000 Tons, of Molasses for consumption by other industries, we will have about 350,000 tons left over as surplus, which means a regular supply of 1,000 tons a day for a plant operating 350 days in a year. The proposed plant, however, will have a daily capacity of mashing 100 tons of Molasses only, as it is intended to prove that such an undertaking is commercially feasible.

5. *Scheme*—This Scheme calls for the controlled fermentation of Molasses into commercial Alcohols. These Alcohols in turn will be converted

into commercial Solvents and Plasticizers which will be used in the manufacture of such Alcohol Products that have a ready market in India. Table I below gives the annual import figures of commercial products, which either contain Alcohol or use Alcohol in some form or other in their process of manufacture, or they represent as by-products of the Alcohol Industry. Table I gives average import figures taken over the past five years from 1930 to 1935 :

TABLE I

No.	Product					Value
						Rs.
1	Acetic acid	..	..	..	..	1,40,000
2	Artificial leather	..	..	..	..	4,40,000
3	Artificial silk	..	..	..	..	3,40,00,000
4	Chemical manures	..	..	..	..	55,10,000
5	Denatured spirits	..	..	..	..	8,45,000
6	Nitrocellulose lacquers	..	..	..	..	14,64,000
7	Polishes of all kinds	..	..	..	..	21,07,000
8	Wines and liquors	..	..	..	..	1,80,00,000
				Total	..	6,25,00,000

All the products listed in Table I above show a steady increase in their early consumption. And if the Indian Alcohol and allied chemical industries be properly developed, most of these products can be profitably manufactured from Indian raw materials in India. The present Scheme makes a moderate start in this direction and proposes to manufacture.

(1) Commercial Alcohols, (2) Commercial Solvents, (3) Spirit Varnishes, (4) Nitro Cellulose Lacquers, (5) Artificial leather, (6) Recovery of by-products like Carbon Dioxide Gas and Fertilizers. These products of Alcohol are dealt with separately both from technical and economic viewpoint.

6. *Commercial Alcohol*—In most Western countries, Industrial Ethyl Alcohol ranks first in quantity and value of production of all organic chemicals. It is the basic raw material in the chemical and process industries and finds application in a multitude of products. For instance the total available capacity in the United States of America for producing industrial Alcohol is over 200 Million Gallons, manufactured mainly from imported Molasses and costing on average Re.1 per maund of Molasses. The methods of production and the controls exercised over mechanical, chemical and biological processes are highly perfected. By our mashing 100 tons of Molasses daily, Alcohol production of 95 per cent. strength will amount to 60,000 imperial gallons. As the Fuel-oil will have to be completely recovered for solvent purposes, about half of the entire Alcohol production can be made into Rectified Spirits of finest quality.

7. The over-all cost of converting Molasses into industrial Alcohol will be annas 4 per imperial gallon of 95 per cent. strength. This includes all manufacturing charges; such as: interest, depreciation, insurance, labour, power, chemicals and overhead. The cost of denaturing, when necessary, will come to 9 pice a gallon. The cost of Molasses, in addition to the conversion costs per gallon of Alcohol, will vary the market price of Molasses.

Table II, gives the conversion cost plus the Molasses cost for producing a gallon of Alcohol, with the price of Molasses ranging from 2 annas to Re.1 per maund of 82 lb.

TABLE III

Molasses price per maund	Alcohol cost per gallon
Rs. a. p.	Rs. a. p.
0 2 0	0 5 0
0 4 0	0 5 9
0 6 0	0 6 8
0 8 0	0 7 8
0 10 0	0 8 6
0 12 0	0 9 3
0 14 0	0 10 3
1 0 0	0 11 2

The present market price of Molasses is 1 anna per maund and allowing another anna per maund to cover the transport and storage charges, the cost per maund when delivered to the proposed Plant Site will not exceed 2 annas per maund. For our calculation purposes, however, we are taking the Molasses cost at 4 annas per maund. Figured on this bases, the overall cost of manufacturing a gallon of Alcohol of 95 per cent. strength, will come to 5 annas and 9 pies which would be the lowest price on record in the world. This is made possible, under the proposed scheme, because of cheap molasses, cheap fuel, and by installing the latest design large Distilling Apparatus, which will be most efficient in performance.

8. Reliable figures for the total consumption of Alcohol in India are not available. There are in operation five distilleries in the United Provinces, five in the Province of Bihar and two distilleries in the Central Provinces, and quite a number of small distilleries spread over other Provinces. The Excise Department, indicates a figure of 10,000 gallons of alcohol a day in the form of country liquors for British India alone. In view of the prohibition movement recently advocated by the Provincial Governments the present demand by the Excise Department must be ignored. The present scheme calls forth the diversion of Molasses-Alcohol into commercial products. It is estimated that over 15,000 gallons of industrial Alcohol a day is consumed by small industries throughout India. And this amount seems negligible when compared to 500,000 gallons consumed daily in the U. S. A. for industrial purposes alone. The imports of Methylated Spirits into India though on decline, still amount to over 100 gallons a day. In the face of these facts, our daily production of 600 gallons of industrial Alcohol could be comfortably absorbed by the Indian market, especially when our cost price amounts to 5 annas and 9 pies per gallon, against the present market price of Re.1-1 per gallon for Rectified Spirits and 10 annas per gallon for the methylated spirit. According to the present scheme, however, most of the Alcohol produced will be diverted into commercial products, which would give better returns per unit sale. And to meet trade requirements for the special quality rectified spirits or denatured spirits, it is intended to dispose of daily some 2,000 gallons of spirits at 9 annas per gallon; thus yielding a net profit of Rs.300 a day on this sale alone.

9. *Alcohol cost analysis*—Our basic raw material is Molasses, one maund of which will cost us 4 annas only and will produce 2·25 imperial gallons of 95 per cent. Alcohol. This means that every gallon of Alcohol made will consume Molasses worth 1 anna and 9 pies. The over-all conversion costs, as stated above, will not exceed 4 annas per gallon, thus bringing the total cost of Alcohol to 5 annas and 9 pies per gallon. The cost of denaturant and other denaturing charges will come to 9 pies per gallon, and this cost has to be incurred, in case the produce has to be sold in the market as denatured spirit, otherwise the net Alcohol cost when used in our own process industries for manufacturing various Alcohol products, will remain at 5 annas and 9 pies a gallon. There can be no question about the availability and cheapness of Molasses, but it may be asked, how the conversion cost of 4 annas per gallon was arrived at. A modern distillery, complete in every respect and capable of treating 100 tons of Molasses a day will cost nearly rupees ten lakhs. In figuring out the conversion costs we must take into account the charges like interest, depreciation and insurance on the capital invested, and to consider other items like labour, power, chemicals, stores and finally the overhead charges. Ordinarily no interest is charged on the paid up capital investment, plant depreciation in case of a distillery is rather small, while insurance rate is slightly higher. In our case we are allowing 6 per cent. 4 per cent. and 2 per cent. respectively on a total investment of rupees ten lakhs which amounts to Rs.1,20,000 a year on an annual production of 18 lakhs gallons of Alcohol. This charge comes to 1 anna per gallon. The daily wages bill consisting of 80 technical and skilled help, will amount to Rs.200 or Rs.75,000 a year. Thus labour charges comes to 6 pies per gallon of Alcohol made; while the overhead charge, which in other words means executive labour, will absorb another sum of Rs.200 a day, or 8 pies a gallon. Regarding power costs it may be mentioned that coal fired steam power plant will be installed, and our average steam consumption will be 25 lb. per gallon of Alcohol made. Our steam generation cost will come to Re.1, per 1,000 lb; thus making the power charge come to 5 pies per gallon of Alcohol made. Taking into consideration the power losses and consumption in other departments of the distillery, it will take another 3 pies of power for every gallon of Alcohol made, thus bringing the total power charge to 8 pies per gallon of Alcohol. Consumption of chemicals and general stores in a year's time will come to Rs.56,000, thus adding another charge of 6 pies to the gallon. Table III below summarizes the over-all cost of making a gallon of Alcohol of 95 per cent. strength, in a distillery having an annual capacity of turning out 18 lakhs gallons of such Alcohol. Molasses cost is taken at 4 annas per maund of 82 lb.

TABLE III

No.	Item	Annual charge	Charge
			Rs. o. p.
A	Cane molasses .. .. .. ..	1,88,000	0 1 9
B	Int., dep., and Insu. .. .. .. ..	1,20,000	0 1 0
C	Labour charges .. .. .. ..	75,000	0 0 8
D	Power costs .. .. .. ..	75,000	0 0 8
E	Chemicals and stores .. .. .. ..	56,000	0 0 6
F	Overhead charges .. .. .. ..	75,000	0 0 8
G	Alcohol losses, etc. .. .. .. ..	..	0 0 6
	Total ..	5,89,000	0 5 9

10. *Commercial Solvents*—In the manufacture of Nitrocellulose Lacquers, Solvents play an important part. The question of rate of drying, flow and gloss and the fine characteristics are vital to Lacquers and these properties can be incorporated by the selective use of a proper blending of solvents which are classified by the trade according to their boiling points. To start with we will be manufacturing a few of the important Alcohol and Ester type of solvents such as: Ethyl Ether; Anhydrous Ethyl Alcohol; Amyl Alcoliol; Amyl Acetate; Ethyl Acetate; Butyl Alcohol, Butyl Acetate, Ethyl Laetate, Ethyl Acetoacetate; Diethyl Oxalate; Diethyl Phthalate; Dibutyl Phthalate and Diamyl Phthalate. This list covers a wide range of boiling points from below 100°C to above 300°C, and will serve most of our requirements for the manufacture of high class Nitrocellulose Lacquers, varnishes and various collodion solutions. In addition to the above active, solvents and plasticizers there are the so-called diluents. The hydrocarbons Benzol, Toluol and Xylool are the most important materials in this class. They are of great value in the blending and compounding of the resin solution with those of nitrocellulose. The presence of moisture is fatal to a Lacquer, therefore the Solvents manufactured under the proposed scheme will be Anhydrous. Absolute Alcohol will be produced by employing the Azeotropic process of distillation.

11. The proposed scheme converts Alcohol into such commercial products that will prove more remunerative than selling it as industrial Alcohol. Table IV illustrates the difference between the price of Alcohol and that of the price of Solvents made therefrom. Price quotations are for the American products f.o.b. New York, reduced to per lb. basis in Indian currency. The last column gives our cost prices for the same products under the proposed scheme:

TABLE IV

No.	Solvent	N. Y. price		Our cost price
		Rs. a. p.	Rs. a. p.	
1	Ethyl Alcohol, 95 per cent.	..	0 2 0	0 0 10
2	Absolute Alcohol	..	0 2 0	0 1 0
3	Amyl Alcohol	..	0 3 3	0 4 0
4	Fusel oil	..	0 7 0	0 6 0
5	Acetic acid	..	0 3 6	0 3 0
6	Ethyl Acetate	..	0 3 3	0 2 0

Foreign manufacturers of Cellulose Lacquers buy their solvents and other raw materials from the outside markets, and they are paying more for their solvent requirements than it will cost us to manufacture under the present scheme, as is evident from Table IV above. On the other hand we will be paying a bit more for the important nitrocelluloses and plasticizers. Still our cost of producing a gallon of finished Lacquers will be less than the cost of any foreign manufacture. This is because Alcohol our basic raw material will cost us nearly half of what it does the foreign manufacturer. The Solvents produced will constitute our main raw materials for the manufacture of Lacquers, Varnishes, Artificial Leather, etc. which at present are entirely imported into India. Therefore, it is proposed to convert the balance of 1,000 gallons of 95 per cent. Alcohol into Commercial Solvents. As there exists good demand for the Commercial Solvents about 1,000 gallons will be sold as solvent which will be equivalent to 1,600 gallons of 95 per cent. Alcohol.

Making 4 annas on a gallon of solvent, our daily profit from the sale of solvents will amount to Rs.400. The balance of the solvents, nearly 1,500 gallons and equivalent to 2,400 gallons of 95 per cent. Alcohol, will be used in the manufacture of Lacquers, Varnishes, etc.

12. NITROCELLULOSE LACQUERS—The use of Cellulose Lacquers began about the middle of last century, but only limited progress was made because of the scarcity, price and nature of available solvents. The real progress of the Lacquers Industry came with the introduction of cheap and ample supply of high boiling Ester solvents, and at the same time development and improvement in the manufacture of low viscosity nitrocelluloses. The use of Lacquers is increasing rapidly and they are gradually replacing the old type of paints and varnishes. In U. S. A. alone the Lacquers sales in the year 1936 reached fifty million gallons. The entire automobile, aeroplane, shipping and railway industries of the world are being finished today with nitrocellulose lacquers because of their quick drying, wide adoptability, attractiveness and long life of their films. Some of the commercial articles on which Nitrocellulose Lacquers and Varnishes are used as finishes are: Artificial Flowers, Artificial Limbs, Automobiles, Baskets, Bathroom Fixtures, Bobbins for spinning, Book ends, Brass goods, Brush handles, Buttons, Cameras, Celluloid articles Clocks and dials, Dolls, Electric fans, Electric goods, Fibre articles, Fire extinguishers, Fishing lines; Fixtures, gas and electric, Floors, Furniture, Games, Gas mantles, Glass shades Hardware, all kinds, Jewellery, Lamps, Linoleum, Loud speakers, Machinery metal furniture, Metal work, all kinds, Musical instruments, Name plates, Novelties, Oil Cans, Optical instrument Pencils, Radio, Pen-holders, Pianos; Picture frames, Pumps, Radio goods and cabinets, Radio Panels, Scientific instruments, Shoe eyelets, Silverware, Steering wheels, Steam gauges, Switch plates, Thermo bottles; Toilet seats and tanks, Tools, Toys, Trunk Hardware; Type-writers, Umbrellas, Vacuum cleaners; Walls of rooms, Washing machines, Window shades, Wooden novelties, etc. etc. From the above list an idea can be formed, how the establishment of Nitrocellulose Lacquer industry in India would help development of so many other industries and to manufacture quality articles with finishes as attractive as seen on the imported articles. It would be the chief concern of the Research Department of the proposed undertaking to give all technical assistance and every facility, free of charge, to the users of our Lacquers, with a view to bring theirs products out in excellent finishes and at prices that will defy foreign competition.

13. In the manufacture of nitrocellulose lacquers, the low viscosity nitro-cotton plays the most important part, and this material has to be imported from firms that specialize in its manufacture on large scale. The finished lacquers contain on the average 11 per cent. by weight of nitrocellulose representing in value nearly 25 per cent. of the total value of the finished lacquer. In the handling and storage of nitrocellulose, the same precautions are required as are necessary for other inflammable products as Petrol, Alcohol, Celluloid and many other articles in common and daily use.

As shipped it contains 30 per cent. of denatured Alcohol and in such condition presents no greater hazard than Alcohol. Transportation by rail or steamer of wet nitrocellulose is allowed by all the foreign countries who classify the material as an "Inflammable Liquid."

14. The Consumption figures for the Paint and Varnish products in India are not available, but considering the large number of paint manufacturing establishments, it is taken that the consumption is fairly large and on

steady increase. Besides our home production, the annual imports of lacquers, varnishes and polishes amount to over Rs.35 lakhs. The imported lacquers like Daco, Valspar, etc., which will be our chief competitors, are being sold today at the Indian Ports at Rs.18 per gallon. Our cost price for the same quality Lacquer, inclusive of all charges and packing will not exceed Rs.10 per gallon and we propose to sell the same at Rs.11 per gallon ex-factory and leaving balance of Rs.7 per gallon to take care of the marketing charges. Provision is made to manufacture 800 gallons of finished lacquers to start with, thus yielding us an income of Rs.800 a day on this account.

**15. VARNISHES:** Spirit Varnishes like Copal and French type are in good demand in the Indian market, due to their comparative cheapness, easy applicability and quick drying, although the film is not lasting. The basic raw materials necessary for their manufacture are : Anhydrous Alcohol, Turpentine, Shellac, etc., which are available in India abundantly and cheaply. Therefore, quality varnishes will be manufactured both for the Indian market, as well as, for export purposes. Our cost of making a gallon of varnish will not exceed Rs.2 per gallon, against the present market price of Rs.3-8 a gallon at the Ports. On the varnish account we will be reserving annas 8 per gallon as our share of the profit, thus on the sale of 500 gallons of Varnish a day, we will have a net income of Rs.250 a day.

**ARTIFICIAL LEATHER:** Mixture of Anhydrous Alcohol, Ether and Ester Solvents are largely used in the manufacture of Artificial Leather. And the present scheme having full facilities of a complete lacquer manufacturing plant, it will be comparatively easier to prepare any specified collodion solution or Dopes for applying to a textile surface instead of a house wall or furniture. The required cloth will be purchased from one of the Indian Textile Mills, and by installing a suitable plant, the cloth impregnation, calendering, embossing, drying and finishing will be done simultaneously and by a continuous process. The import figures of Artificial Leather for the past two years are :

Year	Square yards	Value in Rs.
1934-35 .. .. .. .. ..	726,267	5,39,418
1935-36 .. .. .. .. ..	687,719	4,03,260

There are other articles like Book binding cloth and oil-cloth for which import figures are not available, and they are all manufactured by a similar process that imports a waterproof coating to the surface. The proposed leather plant will have a capacity of turning out finished cloth at the rate of 80 linear yards per working hour, and taking on the average 20 working hours day, our daily production will approximate 1,600 yards. The present market price of average quality leather cloth is Re.1-4 per yard, while our manufacturing cost will come to annas 14 a yard only. We propose to sell our leather cloth at Re.1-2 a yard leaving us a profit of annas 4 a yard, or Rs.400 per working day.

**16. CARBON DIOXIDE:** For every 180 parts of sugar present in Molasses while being fermented into alcohol, some 80 parts of Carbon Dioxide Gas are produced or a theoretical yield of 48.8 per cent. Taking fermentable sugar as 50 per cent. on the weight of Molasses and assuming Gas recovery at 70 per cent. total daily production of commercial Gas either as Liquid or as Dry Ice will amount to 17 tons a day when the

Distillery is mashing 100 tons of Molasses daily. Allowing for stoppages in the Compressor Plant and other incidental shut downs our net daily production of Carbon Dioxide Gas mostly in the form of Dry Ice will average 15 tons, under the proposed scheme. This valuable Gas is by-product of this scheme and its total cost to us will be its purification and compression charges only.

17. Carbon Dioxide Gas is extensively used in Industry and Agriculture. Its main use lies in commercial refrigeration the artificial refrigeration (Dry Ice), now taking the place of old mechanical refrigeration (Ice from water). Carbon Dioxide Gas, when compressed to about 1,000 pounds per square inch at about 60°F, liquifies. In the commercial manufacture of Dry Ice, the liquified gas is allowed to expand through a patented nozzle into large tanks, and the snow produced therein is hydraulically compressed into hard blocks before being exposed to the air, thus forming the Dry Ice. It is snowy white, weighing about 80 pounds to the cubic foot, and has a temperature of 114°F below zero, i.e. 146 degrees colder than water ice. Dry ice contains roughly twice as much refrigeration pound for pound as ordinary ice, which absorbs only 144 B. T. U. per pound at 32°F. Dry ice, as a refrigerant possesses the following advantages to effect its higher cost as compared with water ice :—

- (1) Insulating effect of gas evaporated, permitting slower rate of heat absorption.
- (2) High heat absorptive value per unit of weight.
- (3) Lower temperature as a factor of safety in shipping perishable goods like fruits, vegetable and dairy products.
- (4) Evaporation to a dry gas which reduces maintenance of cars and containers, and prevents heat leakage.
- (5) Carbon Dioxide itself has a slight preservative effect on food stuffs, thus the goods keep longer with its use.
- (6) Light-weight packages of butter, cheese, eggs, ice-cream, confectionary, fruits and vegetables, etc. for shipment by mail or express to cover long distances.
- (7) Ideal refrigerant for the ships, railways and cold storage warehouse, as it will avoid the high cost of mechanical installation and its inefficient operation.
- (8) Dry Ice freezes quick, makes possible shipment and storage of frozen products, and used as local anaesthetic.
- (9) Replacing the liquid gas in the carbonated beverage industry. This will obviate the use of heavy steel cylinders. The use of Dry ice will also eliminate the danger of bursting cylinders and save the capital investment.
- (10) Dry Ice has a large field for use in various fire extinguishing apparatus.

18. It is not possible to over-emphasize the commercial importance of Dry Ice. India being a tropical and agricultural country, the development of Dry Ice Industry will play an important roll in the general economics of the country. For instance in the year 1925, when the writer took up this work, then U.S.A. produced only half a ton of Dry-Ice per day, and the development was so fast that the average daily production for the year 1936 amounted to 350 tons. Nearly 80 per cent. of the former liquid gas has been changed over to Dry Ice. For the first time in India and in the course of last six months only four plants with an aggregate capacity of 15 ton a day are under construction. Prior to this liquid gas was manufactured in various

small plants in India employing the Coke Process and these plants will soon go out of business. Under the proposed scheme, total dry ice available for marketing will be 15 tons per working day. Two compressors of the three-stage intercooled type, each with a rated capacity of 1,000 lb. per hour will be installed. The gas being free and investment and other charges, per ton of Dry Ice, being the minimum, our manufacturing cost per ton of Dry Ice will come to Rs.60 per ton or 5 pies per pound, and we propose to sell the Dry Ice at Rs.85 per ton or 7 pies per pound, thus leaving us a net profit of Rs.25 per ton or Rs.375 a day. At present Dry Ice is being sold at annas 3 per pound or Rs.420 a ton. One new Dry Ice company registered in September, 1937, propose to sell at Rs.210 per ton while its manufacturing cost comes to Re.85 per ton. It is interesting to note that our sale price per ton will be the same if not lower, than the cost price per ton of any Dry Ice establishment in India. This means that others have to wait till we are sold out. On the way industry holds goods future for the investor.

**19. BAKER'S YEAST:** The manufacture of Baker's Yeast and other yeast products constitute a major industry in most western countries, where yeast is employed in the making of daily bread. The Annual sales of one yeast company in the U. S. A. amounted to over Rs.20 crores, showing a net profit of 25 per cent. During the course of fermentation, there is considerable growth of Yeast most of which settles down at the bottom of the fermenters. Using 'A' yeast we will be producing daily some 2,000 gallons of fermenter settling, each gallon weighing about 9½ pounds, and having a moisture content of 75 per cent. Our daily production of dried Yeast will amount to nearly 5,000 pounds which is generally wasted by the distilleries. After secondary fermentation these yeast settling can be filter-passed and moisture content reduced to 50 per cent. As such it is universally sold for bread baking, and also marketed in small tablets wrapped in the soils for table use. It is very rich in proteins and contains on the average 4.5 per cent. Nitrogen. For the first year or so, we are not counting on any returns from this product, but we do expect that the proceeds realized from small sales made either as Baker's Yeast or Cattle Fodder, will more than compensate our recovery costs and at the same time provide funds for the experimental and publicity work for developing the yeast market in India.

**20. POTASH RECOVERY:** Another important feature of this scheme would be the recovery of Potassium Salts and Ammonium Sulphate fertilizers as by-products which in other words would mean putting back into soil, what has been taken out by the cane crop. Countries that lack natural potash resources develop their latent supplies of by-products Potash, and today the American by-product Potash amounting to 500,000 tons a year is largely supplied from the Cement, Alcohol and Iron industries. Some three industries are now well established in India and India if she chooses could become independent of her potash requirements. According to the proposed scheme the residual distillery waste, known as slop, is concentrated to 50 per cent. solids. The thick slop is sprayed into a specially designed combustion chamber, where it is allowed to burn. The ash known as vegetable potash is collected; ground and made ready for use. Potash thus recovered, is a dark material of fine texture, carrying approximately 85 per cent. of K<sub>2</sub>O in the form of water soluble potassium salts. There is also present 1.5 per cent. of available P<sub>2</sub>O<sub>5</sub> and 6.36 per cent N<sub>2</sub>. Again the field experiments have conclusively proved their beneficial effect on the crop growth. As stated in early part of this report, the surplus amount of molasses awaiting economic disposal, approximate 3,50,000 tons annually containing on the average

3·0 per cent. potash, as  $K_2O$ , and 0·2 per cent. Nitrogen as  $N_2$  of which, 60 per cent. of each amounting to 6,000 tons of  $H_2O$  and 400 tons of  $N_2$  can be recovered in commercial practice. When expressed in terms of fertilizer salts, these amount to 17,000 tons of potassium salts and 2,000 tons of ammonium sulphate, recoverable every year, representing an aggregate value of Rs.16 lakhs worth of fertilizers. The annual imports of chemical manures, even at this low stage of our Agricultural development amount to over Rs.55 lakhs. The recovery of fertilizers as outlined above, under the proposed scheme will be taken up as soon as the capacity of the plant will be increased to 200 tons of molasses a day, as below this it will not be economical.

21. FINAL PRODUCTS—Table V below summarizes our list of products as described above and made from 100 tons of molasses per 24 hours. The allocation is only approximate, and the plant design allows flexibility in its various units to meet market requirements. Column 2 gives the unit cost price calculated on lines as detailed in case of alcohol in paragraph 9:

TABLE V

No.	Product	Gallon/Day	Cost/Gal.	Sale, Gal.	Market price
			Rs. a. p.	Rs. a. p.	Rs. a. p.
1	Rectified spirits..	.. 2,000	0 6 6	0 9 0	1 0 0
2	Comm. solvents..	.. 1,000	0 13 0	1 2 0	2 0 0
3	Spt. varnishes ..	500	2 0 0	2 8 0	3 8 0
4	N. C. laquers ..	600	10 0 0	11 0 0	18 0 0
5	Artificial leather, yards ..	1,000	0 14 0	1 2 0	1 8 0
6	Dry ice ..	1 ton	0 0 5	0 1 0	0 2 0

The total cost of making the above product amounts to Rs.11,000 a day and the same will be sold to trade, ex-our works, for Rs.13,500, thus leaving us a net profit of Rs.2,500 a day, and according to the current market prices, the above products are worth Rs.25,000—nearly 44 per cent. higher than our proposed sale prices. Such plants work three shifts of 8 hours each, and continue working throughout the year with occasional stops for repairs. Taking 300 as actual working days in a year, the annual profit would amount to Rs.7,50,000 on capital investment of Rs.25,00,000 only.

22. CAPITAL INVESTMENT—Capital distribution as given in Table VI, below is only approximate. There will be certain departmental adjustments, but the total investment in plant will not exceed Rs.20 lakhs: The amount allotted to each department covers everything like cost of machinery, plant, buildings, installation charges, etc. Besides capital investment of Rs.20 lakhs another sum of Rs.5 lakhs will be required as working capital :

TABLE VI

No.	Department.	Amount			
		Rs.			
1	Power plant ..	..	..	..	3,50,000
2	Water service ..	..	..	..	50,000
3	Still-house ..	..	..	..	3,00,000

No.	Department	Amount
		Rs.
4	Anhydrous Alcohol Unit .. .. .. .. ..	1,00,000
5	Formenter buildings.. .. .. .. ..	1,00,000
6	Ester building .. .. .. .. ..	1,50,000
7	Ether plant .. .. .. .. ..	50,000
8	Vinegar plant .. .. .. .. ..	60,000
9	Dry ice plant .. .. .. .. ..	1,80,000
10	Lacquer manufacturing plant .. .. .. .. ..	1,25,000
11	Art leather plant .. .. .. .. ..	1,20,000
12	Molasses and product storage .. .. .. .. ..	1,25,000
13	Drums and packing department.. .. .. .. ..	50,000
14	Research and control laboratory .. .. .. .. ..	50,000
15	Mechanical Workshop .. .. .. .. ..	50,000
16	Lands, building, railway siding.. .. .. .. ..	1,50,000
	Total .. .. .. .. ..	20,00,000

23. FINANCE AND MANAGEMENT—Briefly, the essentials to be considered in launching a new enterprise are :

- A. The Undertaking itself.
- B. The Management.
- C. The Finance.

A. There is no question about the urgency of the undertaking for the disposal of Molasses. It has become an all-India question, and every sugar factory, especially those situated in Bihar and United Provinces, would welcome to an extreme degree any enterprise that will convert their waste Molasses into valuable commercial commodities. The present manufacturing scheme though new to India, has long been established abroad on most profitable basis and there is nothing experimental about the scheme. The proposed Plant will be employing the latest design machinery equipment and process technique and will be under the charge of an expert who has long experience of the Industry in all its aspects. The same Expert, has been manufacturing abroad similar products, in a Chemical-Distillery nearly ten times the size of the proposed Plant, and has in his possession numerous technical reports, formula, manufacturing data and drawings on which the proposed scheme is based. The expert is also in close touch with the recent development this industry is making abroad. Therefore, the enterprise, as far as, its technical side is concerned, is a sound one. Again there will not arise any question of infringement of Patent rights over any of the equipment, or process employed under the proposed scheme. Regarding its commercial side, the survey shows, that there exists a good profitable market for the products, and it will be a boon to the consumers who will be paying 44 per cent. less than the present market prices. Again the availability of cheap molasses, fuel and absence of internal or foreign competition ensure continued success and expansion of the enterprise.

B. The Management and executive authority will rest with a Board of Directors consisting of 5 to 7 Directors. These Directors need not necessarily be heavy investors, but they must be men of vision, possessing industrial experience and commanding public confidence. It is, therefore, advisable that the Directors be selected carefully, because a properly selected

Board, is one of the best important assets with which a firm can supply itself. It will not only attract the required capital, but induce men of proven merits to join the organization, thus ensuring its success. Subject to the strict control and supervision of the Board, the actual work of the organization in all its departments will be carried on by a wholetime Managing Director, who will be assisted by four departmental heads in charge of (1), Production (2). Sales, (3) Purchases and (4) Research.

C. Total capital investment will be Rs.20 lakhs. It is realized that before the desired capital will be forthcoming certain requirements in the minds of prospective investors must be satisfied and the three elements that generally influence their decisions would be : (1) Income (2) Control and (3) Risk. The Scheme on careful analysis promises a return of at least 30 per cent. on total capital investment of Rs.25 lakhs of which Rs.5 lakhs is the working capital. If out of Rs.25 lakhs total issue, Rs.10 lakhs, be issued as preference stock at 6 per cent. fixed dividend the returns on the common stock issue will come up to 46 per cent. The entire management and business policy will be controlled by the investing public through a duly elected Board of Directors. And the scheme, being assured of the necessary technical skill, raw material and ready market for the products, the risks involved are reduced to minimum.

24. EMPLOYMENT—The present scheme, even in its moderate form will be directly responsible for daily employment of nearly 200 hands as permanent staff throughout the year, and indirectly will help as many more hands who will be engaged in the transport, storage and supply of Molasses, and quite a number in the sale and distribution of our finished products. Of the permanent staff of 200, nearly 100 will be graduates recruited from Indian Science and Engineering Colleges, another 50 will be skilled workers, and the remaining 50 will consist of unskilled labour. This being a chemical and highly specialised industry, it holds out good future for the employment of technical graduates and those with aptitude for industrial research work. This scheme has a vast scope for development and will ultimately lead to the establishment of several small scale industries as discussed above under industrial Alcohol Lacquers, thus helping the employment question considerably.

25. PROSPECTUS—The proposed Scheme consuming only one-tenth of the available molasses supply is only a small beginning to satisfy part of country's requirements of Alcohol Products. With the fast development of small chemical and pharmaceutical industries, it is certain, that soon after the successful operation of the proposed Plant, not only its own capacity will be increased to enable us to recover the valuable fertilizers but another plant, in somewhat modified form will be set up to serve the distant markets of India. Another large and staple industry that could be developed in India on profitable basis, which at the same time will consume large volume of industrial Alcohol would be the establishment of an Artificial Silk Factory. In the Chardonnet process of Artificial Silk making, nitro-cotton is dissolved in Alcohol-Ether mixture, and the solution is squirted through jets; while the latest type of Cellulose Acetate Silk known in the trade as "Celoneso," is prepared by heating cotton with Acetic Anhydride, Acetic Acid and a catalyst. The annual imports of Artificial Silk into British India alone amount to over Rs.3·5 crores. Considering the magnitude of Alcohol Industry abroad and the large imports into India of Alcohol-bearing products, it will be no exaggeration to state that within a few years, we will be able to solve our Molasses

problem. Instead of wasting over 350,000 tons of Molasses a year, we will be converting them into commercial products valued at Rs.5 crores, and this will be no small achievement in our national economy. Mention may be made, that the success of the prohibition movement will depend upon the successful solution of the molasses problem, because molasses will ferment despite the prohibition law, and one hundred of molasses will give to the Boot-legger, 15 bottles of country liquor at practically no cost.

P. S. MAKER.

CAWNPORE :

*The 1st June, 1938.*

